Solution – IAT-2

Q)1 a) In slotted ALOHA network transmits 200 bit frames on a shared channel of 200 Kbps. What is the throughput if the system produces: -

a) 1000 frames/sec b) 500 frames/sec c) 250 frames/sec

Solution

This situation is similar to the previous exercise except that the network is using slotted ALOHA instead of pure ALOHA. The frame transmission time is *200/200* kbps or 1 ms.

a. In this case G is 1. So $S = G \times e^{-G}$ or $S = 0.368$ (36.8 percent). This means that the throughput is 1000 x 0.0368 = 368 frames. Only 368 out of 1000 frames will probably survive. Note that this is the maximum throughput case, percentagewise.

b. Here G is $\frac{1}{2}$. In this case $S = G \times e^{-G}$ or $S = 0.303$ (30.3 percent). This means that the throughput is 500 x 0.0303 = 151. Only 151 frames out of 500 will probably survive.

c. Now G is $\frac{1}{4}$. In this case $S = G \times e^{-G}$ or $S = 0.195$ (19.5 percent). This means that the throughput is 250 x 0.195 = 49. Only 49 frames out of 250 will probably survive.

Q1) b) Show the behavior of the three persistence methods of CSMA with a neat diagram

Persistence Methods

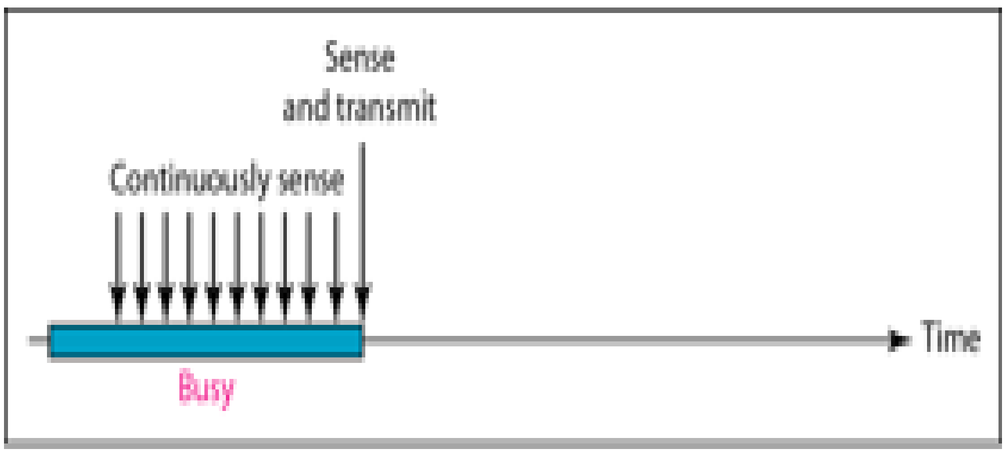
- Persistence methods defines what a station should do if it finds the channel to be busy or idle.

- Three methods :

- 1-persistent method
- Non persistent method
- p-persistent method.

1-Persistent :

- In this method, the station keeps on sensing the channel, if the station finds the line idle, it sends its frame immediately with probability 1.
- This method has the highest chance of collision because two or more stations may find the line idle and send their frames immediately.

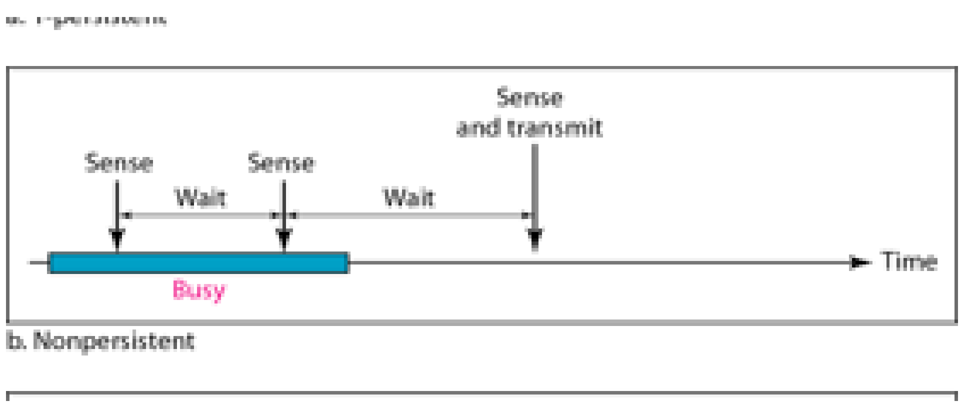


a. 1-persistent

1-Persistent-after station finds the line idle, send its frame

Non persistent ; In the non persistent method, a station that has a frame to send senses the line.

- If the line is idle, it sends immediately. If the line is not idle, it waits a random amount of time and then senses the line again.
- The non persistent approach reduces the chance of collision because it is unlikely that two or more stations will wait the same amount of time and retry to send simultaneously.
- this method reduces the efficiency of the network because the medium remains idle when there may be stations with frames to send.



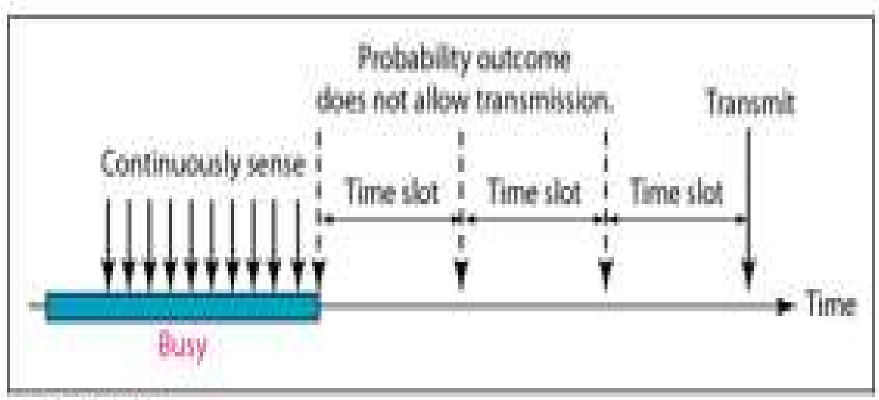
Nonpersistent-senses the line; idle: sends immediately; not idle: waits random amount of time and senses again

p-Persistent:

- Combines the advantages of the other two strategies. It reduces the chance of collision and improves efficiency.
- Channel has time slots equal to propagation time.
- In this method, after the station finds the line idle it follows these steps:

  1. With probability *p, the station sends its frame.*
  2. With probability *q = 1 - p, the station waits for the beginning of the next time slot* and checks the line again.

- a. If the line is idle, it goes to step 1.
- b. If the line is busy, it acts as though a collision has occurred and uses the backoff procedure.



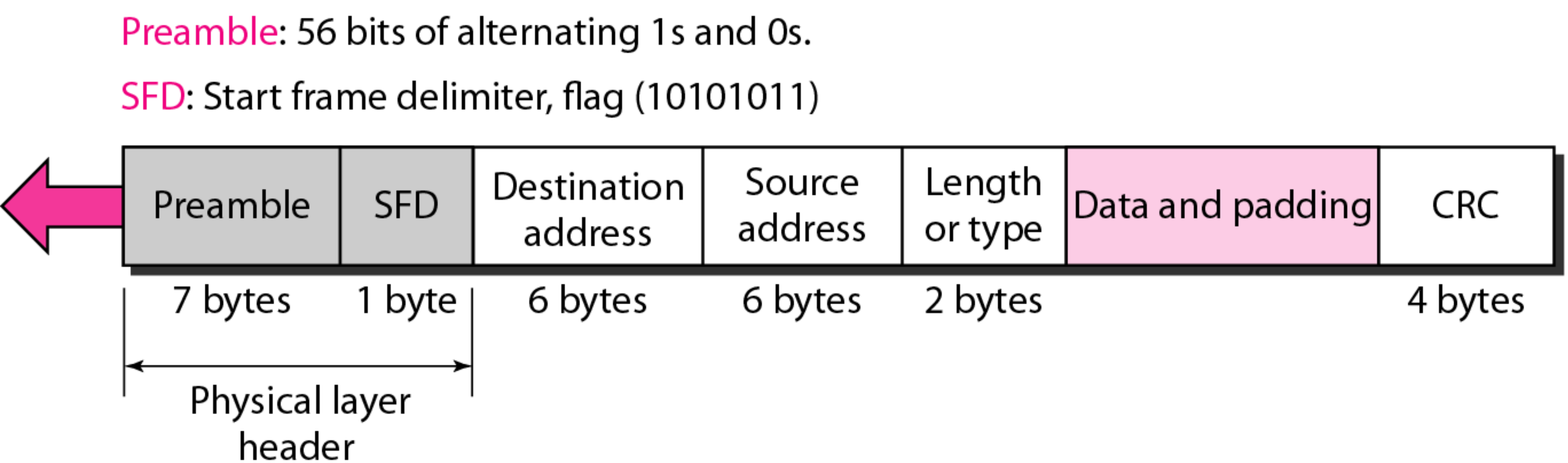
c. p-persistent

p-Persistent-the channel has time slots with duration equal to or greater than max propagation time

Q2) a) Explain the frame format of standard Ethernet (802.3).

Solution

802.3 MAC frame format Ethernet Frame format



Ethernet Frame format

- Preamble:

  8 bytes with pattern 10101010 (alternated 0s and 1s) that alerts the receiving system for the incoming frame and synchronize it with sender clock rates.

- SFD: Start Frame Delimiter:

✓ The second field (1byte:10101011) signals the beginning of the frame.

✓ The SFD warns the station that this is the last chance for synchronization .

✓ The last 2 bits is11 and alerts the receive that the next field is the destination address.

Ethernet Frame format

- Destination Address:
  The DA field is 6bytes and contain the physical address of the destination station to receive the packet.

- Source address:
  The SA field is also 6 bytes and contains the physical address of the sender of the packet.

- Length/type:
  This field defines the type or length of encapsulated in the frame., This protocol can be IP, ARP, OSPF and so on.

Ethernet Frame format

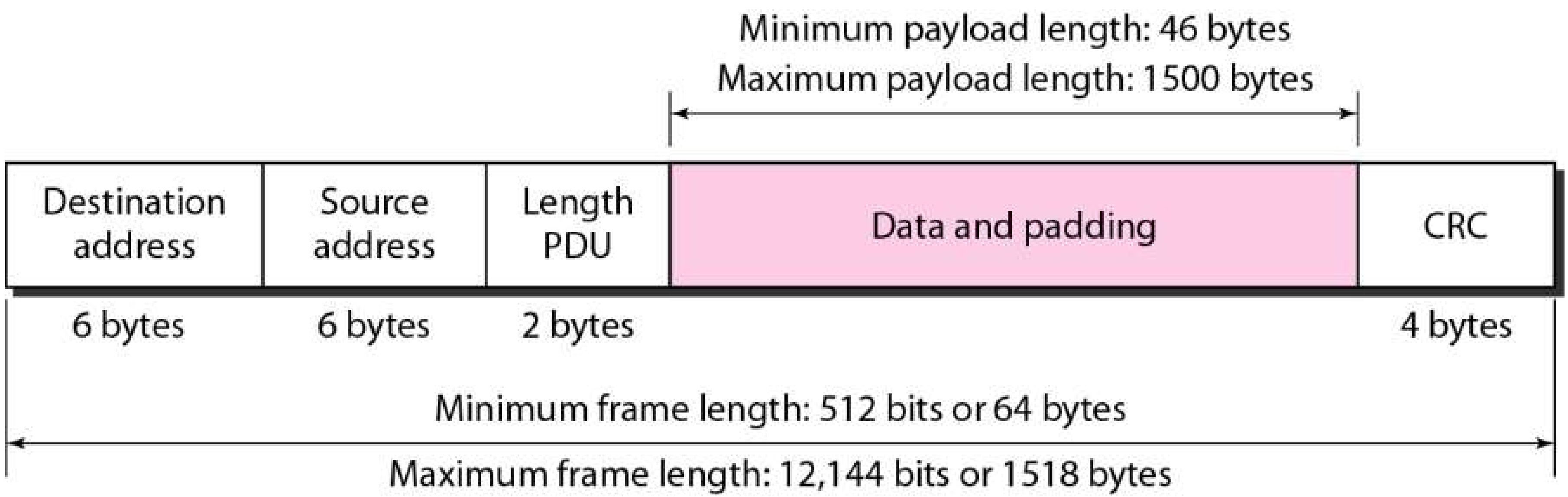
- Data and Padding:
  - This field carries data encapsulated from the upper –layer protocols.
  - It is a minimum of 46 and a maximum of 1500 bytes.
  - If the data is more than 1500 bytes then data should be
  - fragmented but if less then extra zeros should be added.

- CRC :

  The last filed contains error detection information, in this case

  a CRC-32.

Minimum and maximum Frame lengths



Frame length:
Minimum: 64 bytes (512 bits)
Maximum: 1518 bytes (12,144 bits

- The minimum length is required for the correct operation of CSMA/CD.
- The maximum length is used to reduce the size of the buffer.

Frame length:

Minimum: 64 bytes (512 bits)

Maximum: 1518 bytes (12,144 bits)

- Let the header and trailer length is 18 bytes, hence the payload or data length = 64-18 = 46 bytes.
- If the data length is less then 46 bytes then then zero bit padding need to be done.

ADDRESSING :

Each station on a Ethernet network (such as PC ,workstation or printer) has its own network interface card (NIC).

The NIC fits inside the station and provides the station with a 6-byte physical address . written in hexadecimal notation , with a colon between the bytes.

The least significant bit of the first byte defines the type of address . If the bit is 0 ,the address is unicast ; otherwise , it is multicast.

- A unicast address defines only one recipient ; the relationship between the sender and the receiver is one-to-one.
- A multicast address defines a group of addresses ; the relationship between the sender and the receiver is one-to-many.
- The broadcast destination address is a special case of the multicast address in which all bits are 1s.

b. Identify if the following Ethernet MAC addresses are unicast, multicast or broadcast.

41:20:1B:2E:08:EE ii) 4A:FF:10:01:11:00 iii) FF:FF:FF:FF:FF:FF

Define the type of the following destination addresses:

a. 41:20:1B:2E:08:EE
b. 4A:FF:10:01:11:00
c. FF:FF:FF:FF:FF:FF

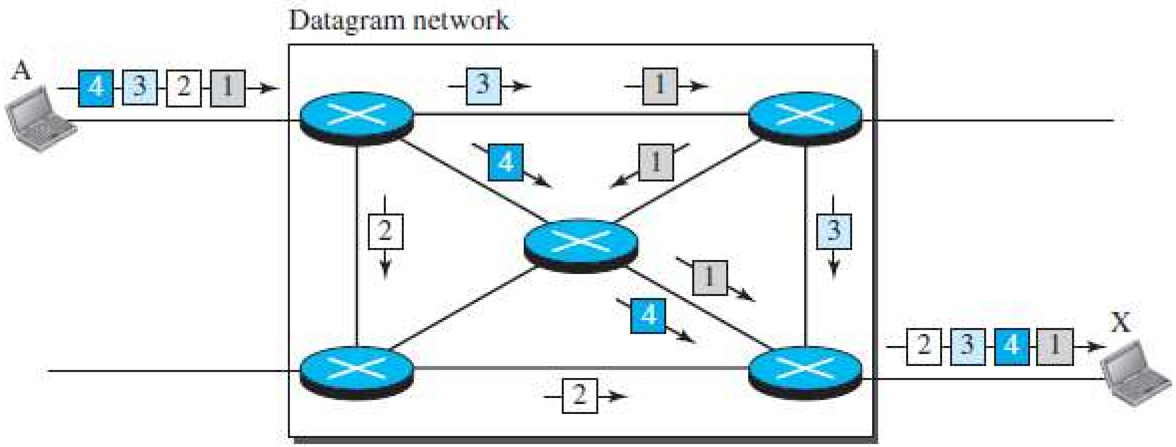
Solution

a. This is a multicast address because 1 in binary is 0001.
b. This is a uicast address because A in binary is 1010.
c. This is a broadcast address because all digits are F's.

.Q) 3 Explain the datagram approach in case of connectionless service to route the packet.

Solution:

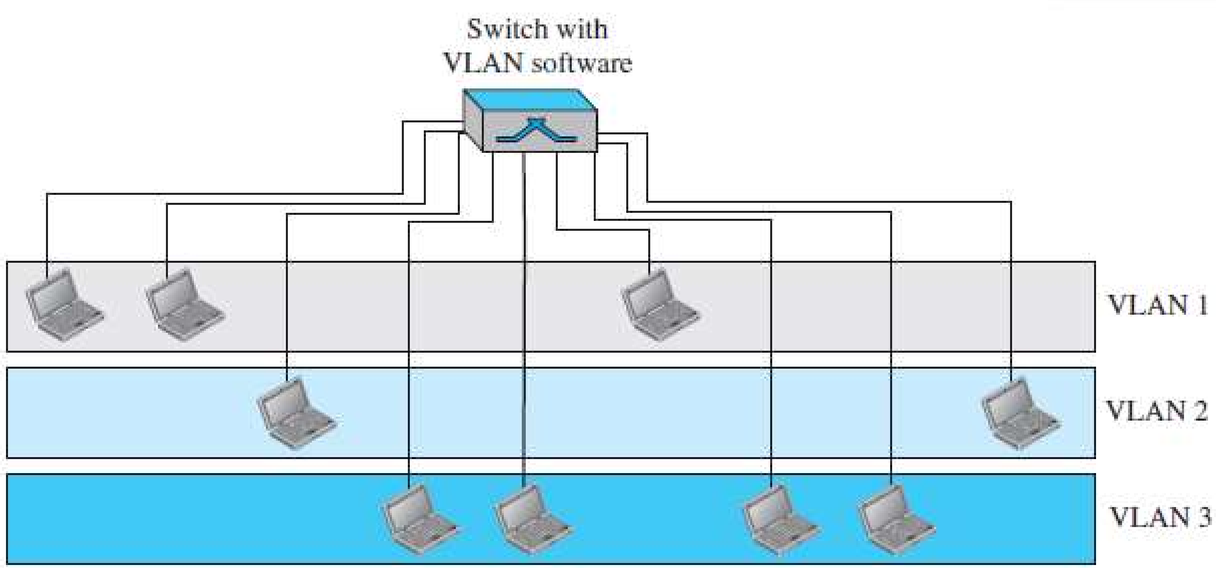
In packet switching, there is no resource allocation for a packet. This means that there is no reserved bandwidth on the links, and there is no scheduled processing time for each packet. Resources are allocated on demand. The allocation is done on a firstcome, first-served basis.



In this figure, all four packets (or datagrams) belong to the same message, but may travel different paths to reach their destination. This is so because the links may be involved in carrying packets from other sources and do not have the necessary bandwidth available to carry all the packets from A to X. This approach can cause the datagrams of a transmission to arrive at their destination out of order with different delays between the packets. Packets may also be lost or dropped because of a lack of resources. In most protocols, it is the responsibility of an upper-layer protocol to reorder the datagrams or ask for lost datagrams before passing them on to the application. The datagram networks are sometimes referred to as connectionless networks.

Q 3 b) Explain VLAN and membership of VLAN.

The whole idea of VLAN technology is to divide a LAN into logical, instead of physical, segments. A LAN can be divided into several logical LANs, called VLANs. Each VLAN is a work group in the organization. If a person moves from one group to another, there is no need to change the physical configuration. The group membership in VLANs is defined by software, not hardware.



Membership In VLAN:

Can be done by using
interface numbers, port numbers, MAC addresses, IP addresses,
IP multicast addresses, or a combination of two or more of these.

Interface Numbers

Some VLAN vendors use switch interface numbers as a membership characteristic. For example, the administrator can define that stations connecting to ports 1, 2, 3, and 7 belong to VLAN 1, stations connecting to ports 4, 10, and 12 belong to VLAN 2, and so on.

MAC Addresses

Some VLAN vendors use the 48-bit MAC address as a membership characteristic. For example, the administrator can stipulate that stations having MAC addresses E2:13:42:A1:23:34 and F2:A1:23:BC:D3:41 belong to VLAN 1.

IP Addresses

Some VLAN vendors use the 32-bit IP address as a membership characteristic. For example, the administrator can stipulate that stations having IP addresses 181.34.23.67, 181.34.23.72, 181.34.23.98, and 181.34.23.112 belong to VLAN 1.

Multicast IP Addresses

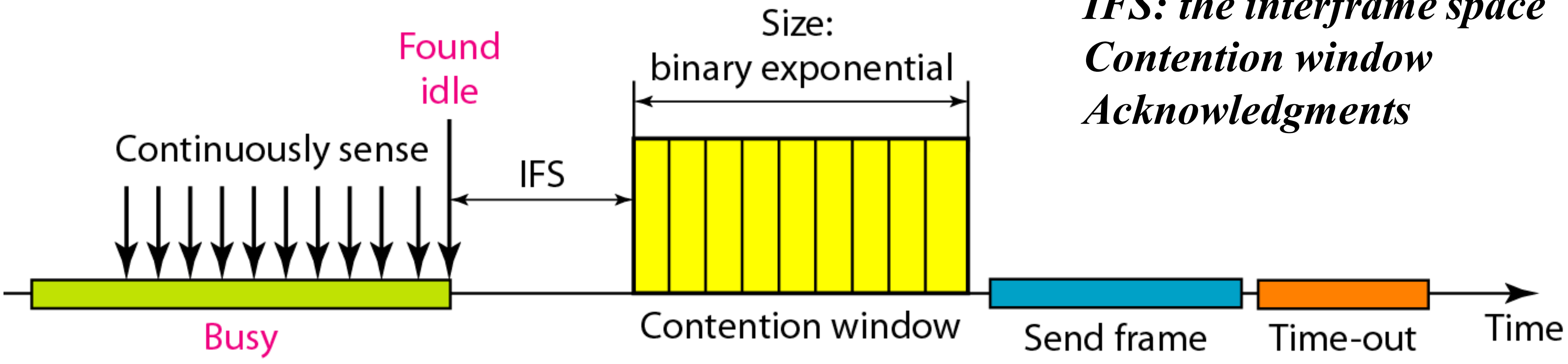
Some VLAN vendors use the multicast IP address as a membership characteristic. Multicasting at the IP layer is now translated to multicasting at the datalink layer.

Combination

The Administrator can choose one or more characteristics when installing the software. In addition, the software can be reconfigured to change the settings.

Q 4 Explain how the collisions are avoided through use of IFS, contention window and acknowledgements in CSMA/CA with neat figure.

Solution : Collisions are avoided through the use of CSMAICA's three strategies: the interframe space, the contention window, and acknowledgments



IFS: the interframe space
Contention window
Acknowledgments

Collision avoidance in CSMA/CA:

<u>Continuously sense:</u>

- First the channel keeps on sensing the medium to be free.
- If the channel is busy the station will backoff
- If the channel is free (i.e. idle) then the station will not immediately transmit the frame but will wait for a period called interframe space

<u>Interframe space (IFS):</u>

- IFS time period is required as if some other distinct stations are already transmitting then let them finish the transmission first.
- After the IFS period if the station founds the channel to be free then it again waits for time period equal to contention window.
- IFS also assigns the priorities to the stations and frame, for example the station that has the short IFS is assigned highest priority.

Contention window:

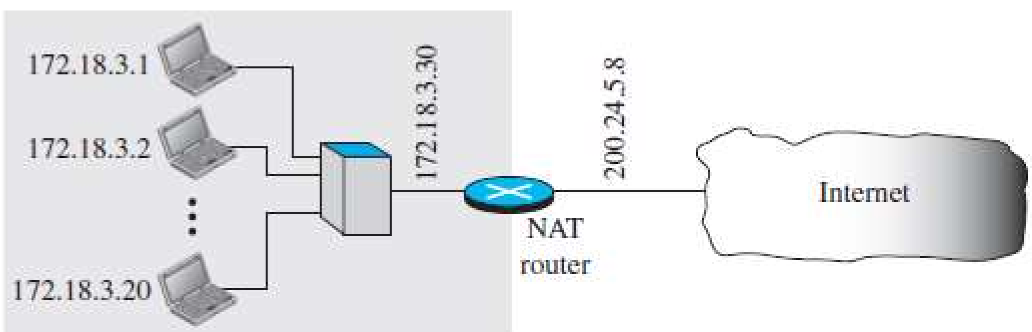
- The complete period of the window is divided into time slots.
- The station which is ready to transmit chooses the random number of time slots as its waiting time period.
- At the beginning of each time slot the station senses the channel to be free.
- If the channel is free then it start the timer and immediately transmits the frame.
- But if the channel is not free then this waiting time period doubles each time according to binary exponential backoff strategy.
- The timers helps to find the stations with the longest time waiting period. (This gives priority to the station with the longest time period.)

Acknowledgement:

After all the precautions if the data is corrupted then the positive acknowledgements and timers guarantees that the frame has been received.

Q 5) Explain the implementation of Network Address translation (NAT) and explain the address translation using different procedure with neat diagram.

Solution: The technology allows a site to use a set of private addresses for internal communication and a set of global Internet addresses (at least one) for communication with the rest of the world.



Site using private addresses

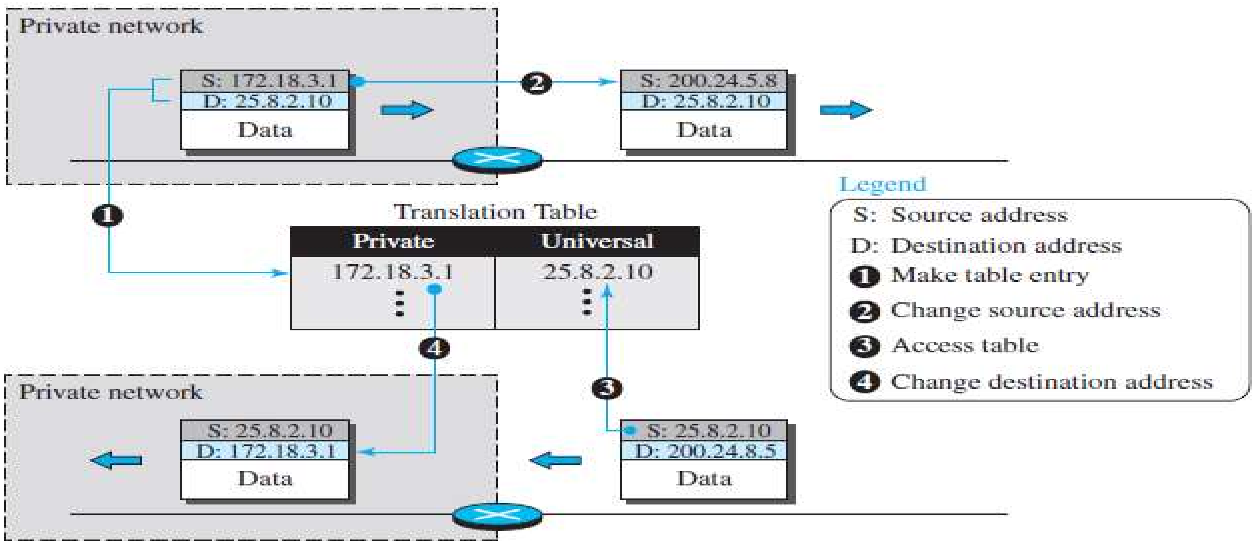
Address Translation:

All of the outgoing packets go through the NAT router, which replaces the source address in the packet with the global NAT address. All incoming packets also pass through the NAT router, which replaces the destination address in the packet (the NAT router global address) with the appropriate private address.

Translation Table

The reader may have noticed that translating the source addresses for an outgoing packet is straightforward. But when the packet is coming from the Internet then to find the destination address. The router maintains the translation table

When the router translates the source address of the outgoing packet, it also makes note of the destination address— where the packet is going. When the response comes back from the destination, the
router uses the source address of the packet (as the external address) to find the private address of the packet



Private network
S: 172.18.3.1
D: 25.8.2.10
Data
S: 200.24.5.8
D: 25.8.2.10
Data
Translation Table
Private
Universal
172.18.3.1
25.8.2.10
Private network
S: 25.8.2.10
D: 172.18.3.1
Data
S: 25.8.2.10
D: 200.24.8.5
Data
Legend
S: Source address
D: Destination address
1 Make table entry
2 Change source address
3 Access table
4 Change destination address

Using a Pool of IP Addresses

The use of only one global address by the NAT router allows only one private-network host to access a given external host. To remove this restriction, the NAT router can use a pool of global addresses. For example, instead of using only one global address (200.24.5.8), the NAT router can use four addresses (200.24.5.8, 200.24.5.9, 200.24.5.10, and 200.24.5.11).

Using Both IP Addresses and Port Addresses

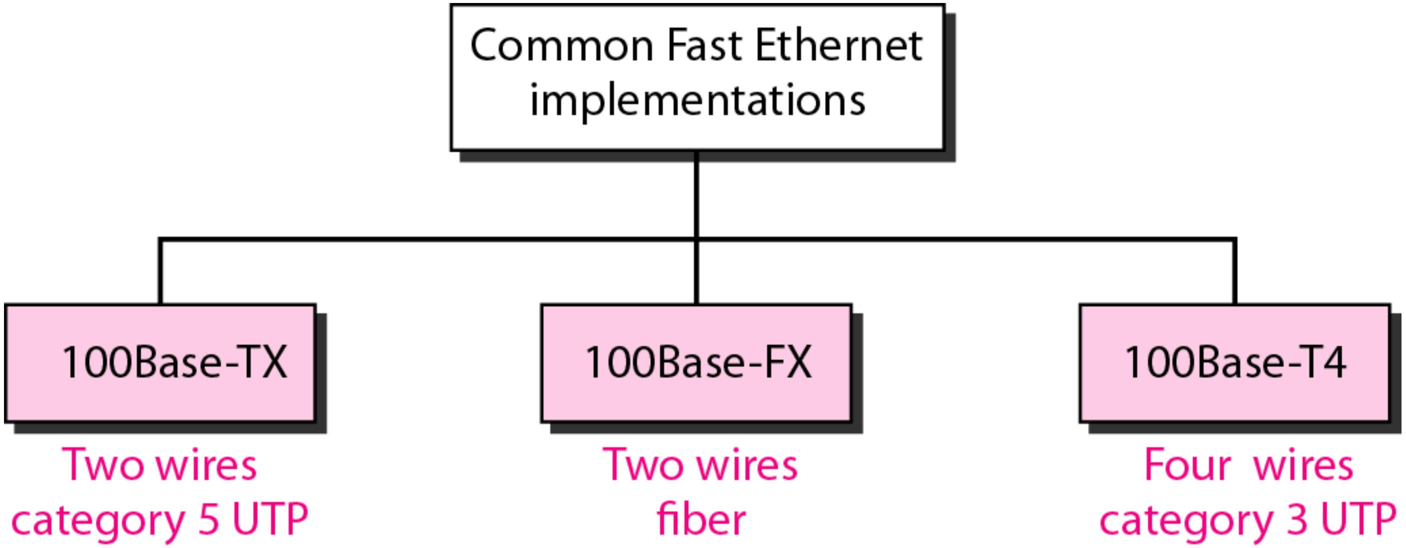
To allow a many-to-many relationship between private-network hosts and external server programs, we need more information in the translation table. For example, suppose two hosts inside a private network with addresses 172.18.3.1 and 172.18.3.2 need to access the HTTP server on external host 25.8.3.2.

Q 6) List the goals of fast Ethernet and also explain the encoding schemes of fast Ethernet

Solution:

- Upgrade the data rate to 100Mbps.
- Make it compatible with standard Ethernet.
- Keep the same 48 bit-address.
- Keep the same frame format.
- Keep the same minimum and maximum frame lengths.

Fast Ethernet implementations



UTP: Unshielded Twisted pair cable
FX: Fiber Optics cable

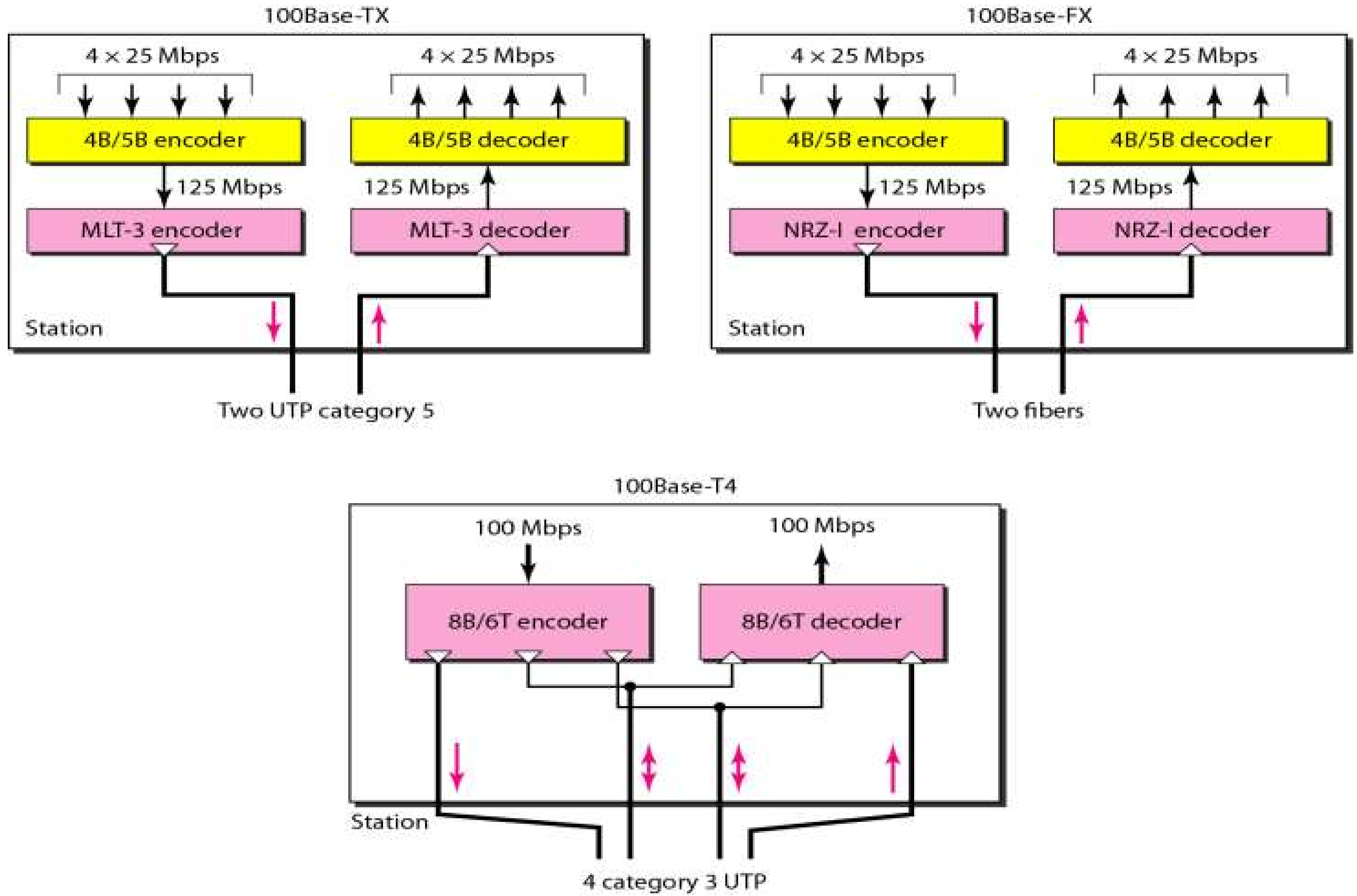
Fast Ethernet (100 Mbps Ethernet) can be implemented using twisted-pair copper wire or fiber media.

100 Mbps Fast Ethernet

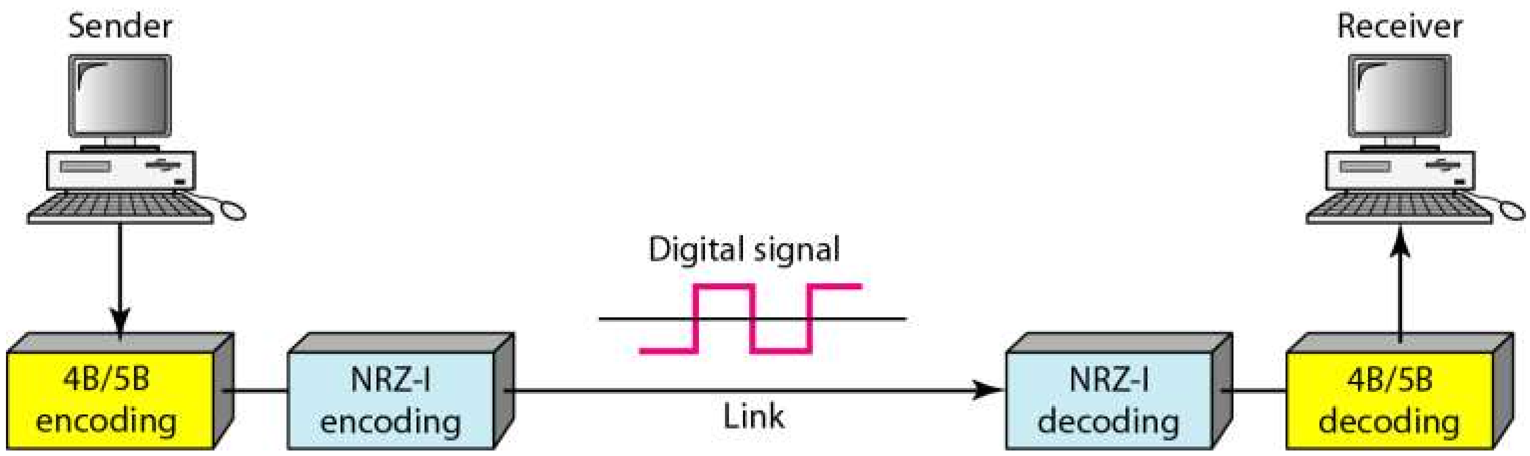
- 100BASE-TX (Cat5 or later UTP)
  - 100BASE-TX was designed to support transmission over either two pairs of Category 5 UTP copper wire or two strands of optical fiber.
  - 100BASE-TX uses 4B/5B encoding scheme.
- 100BASE-FX (fiber-optic cable)
  - 100BASE-FX standard uses optical fiber media.
  - 100BASE-FX also uses uses 4B/5B encoding scheme.

100BASE-T4 (fiber-optic cable)

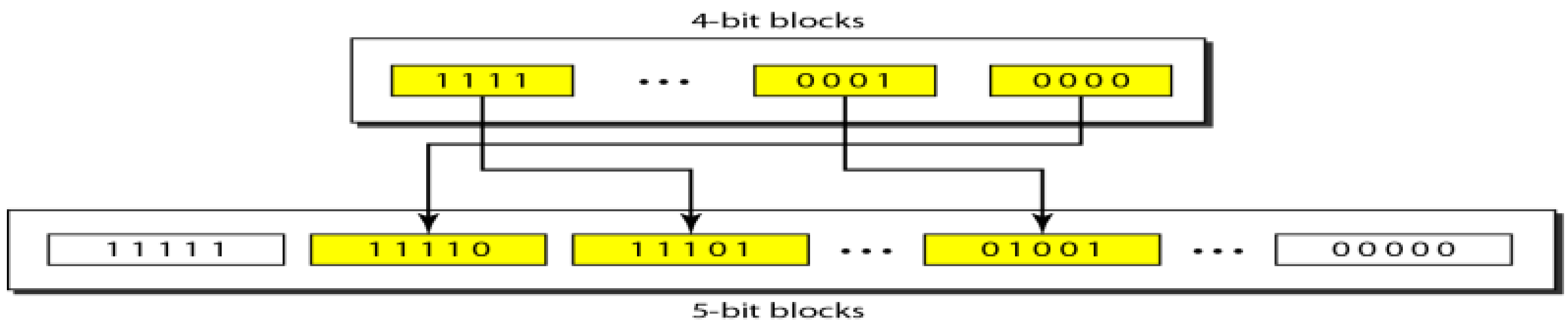
Encoding for Fast Ethernet implementation



100base FX Encoding Scheme

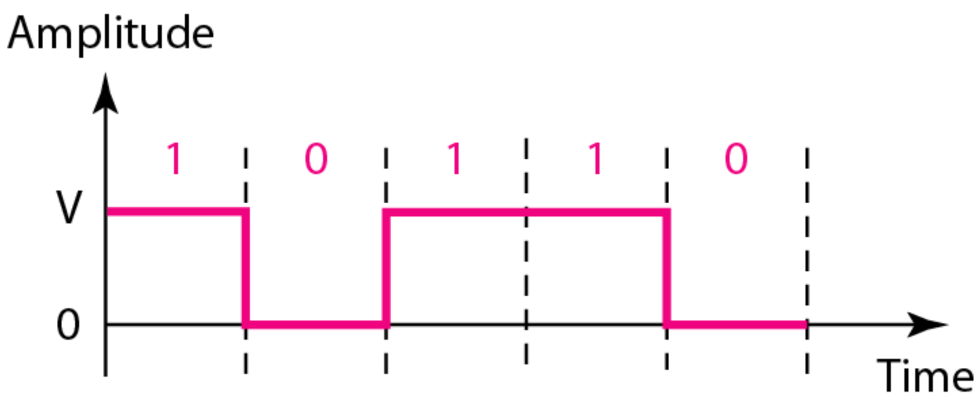


Block coding 4B/5B with NRZ-I line coding scheme for



4Bits are encoded to 5Bits.

NRZ (Non Return to Zero)scheme



$$\frac{1}{2}V^2 + \frac{1}{2}(0)^2 = \frac{1}{2}V^2$$

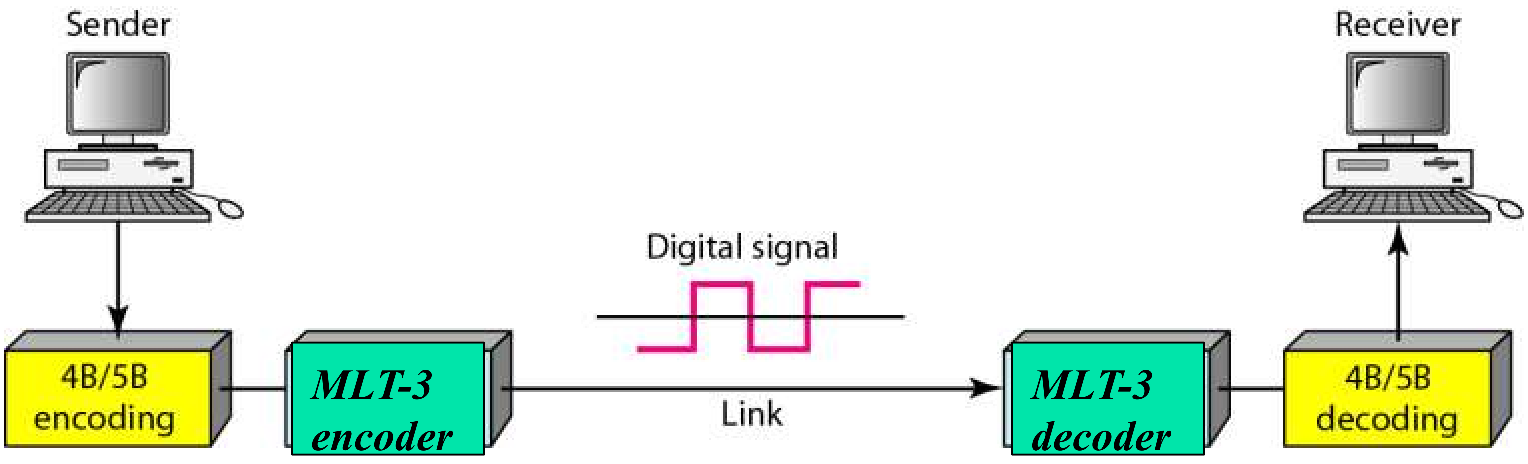
Normalized power

NRZ (non-return-to-zero) refers to a form of digital data transmission in which the binary low and high states, represented by numerals 0 and 1, are transmitted by specific and constant DC (direct-current)

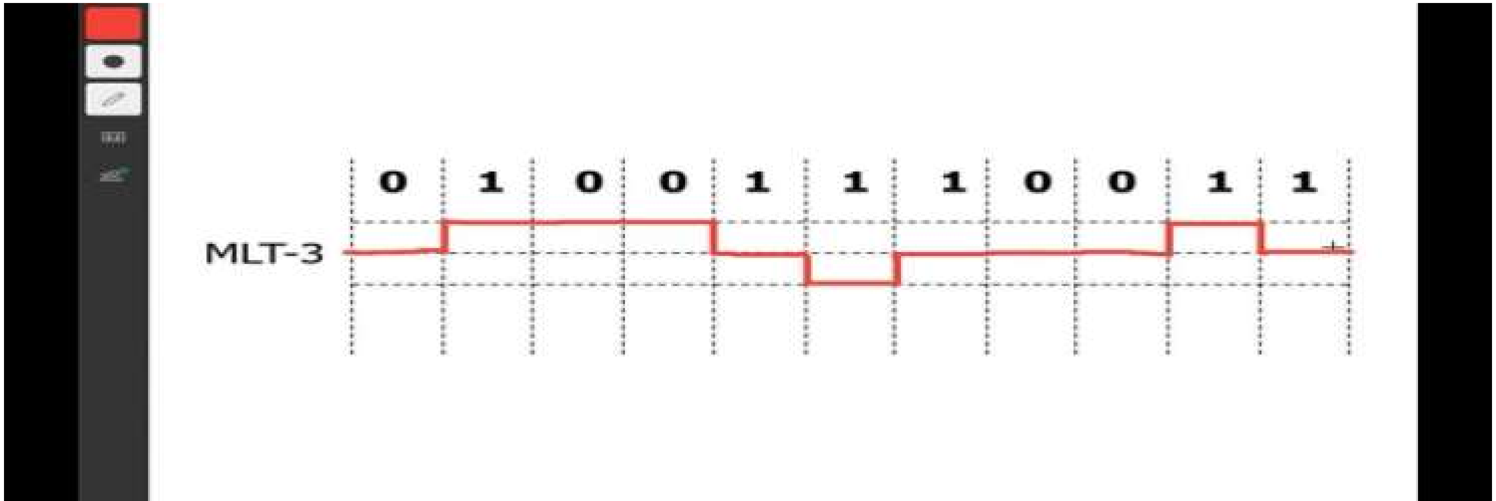
100 BASE FX

- Uses two optical fibers, one for transmission and one for reception.
- Uses FDDI technology of converting 4B/5B to NRZI code group streams into optical signals.

100base TX Encoding Scheme



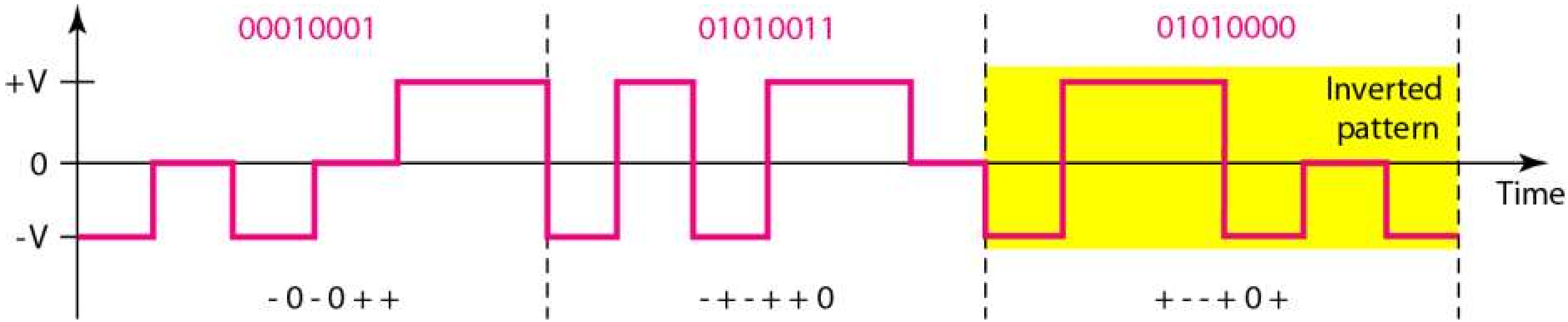
4B/5B encoding scheme is used along with MLT-3 encoding (Multi-Level Transmit). MLT-3 uses three voltage levels -1,0,+1.



100 Base TX

- Uses two pair of twisted pair, one pair for transmission and one pair for reception.
- Uses either STP or Cat 5 UTP.
- Uses MTL-3 signaling scheme that involves three voltages.
- Uses 4B/5B encoding.
- There is a guaranteed signal transition at least every two bits.

100base T-4



Multilevel: 8B6T scheme

100 BASE T4

- Can use <u>four</u> separate twisted pairs of Cat 3 UTP
- Utilize three pair in both directions (at 33 1/3 Mbps) with other pair for carrier sense/collision detection.
- Three-level ternary code is used **8B/6T.**

  Prior to transmission each set of 8 bits is converted into 6 ternary symbols.

Q 7) Explain the loop problem in learning switch. A system with four LANs and five switches are shown in the below. Choose S1 as the source node. Show the forwarding and blocking ports, after applying the spanning tree procedure with proper steps.

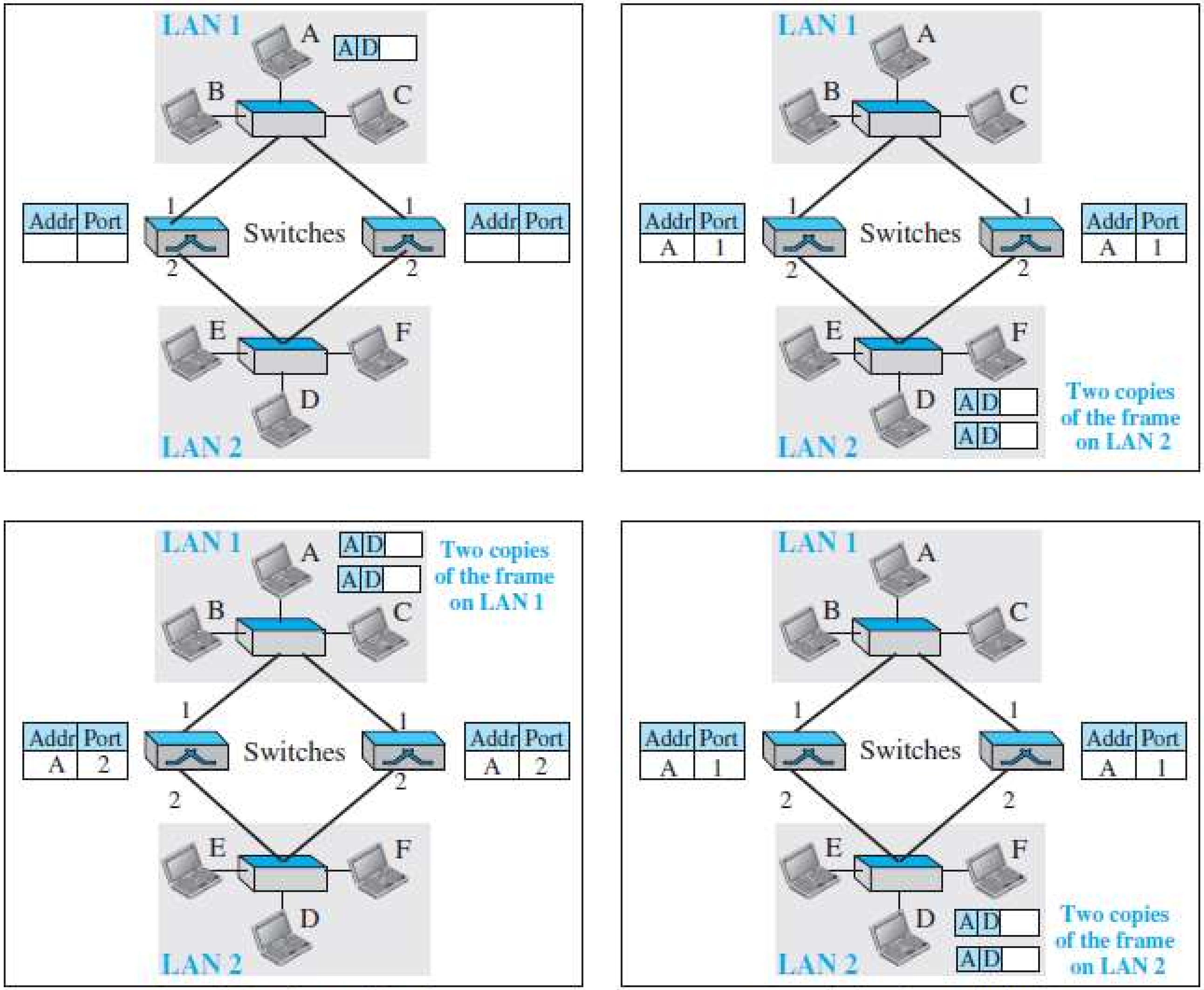
Solution: LOOP PROBLEM

1, Let Station A sends a frame to station D. The tables of both switches are empty. Both forward the frame and update their tables based on the source address A.

2. Now there are two copies of the frame on LAN 2. The copy sent out by the left switch is received by the right switch, which does not have any information about the destination address D; it forwards the frame. The copy sent out by the right switch is received by the left switch and is sent out for lack of information about D. Each frame is handled separately because switches and the tables of both switches are updated, but still there is no information for destination D.

3. Now there are two copies of the frame on LAN 1. Step 2 is repeated, and both copies are sent to LAN2.

4. The process continues on and on. Note that switches are also repeaters and regenerate frames. So in each iteration, there are newly generated fresh copies of the frames.

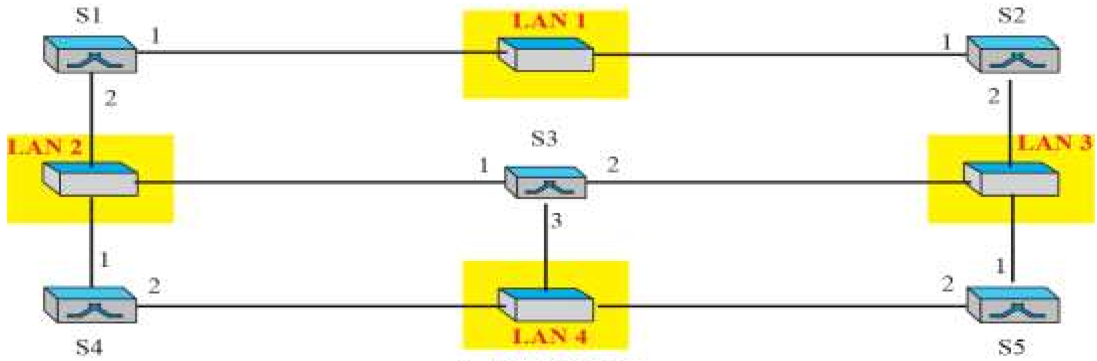


a. Station A sends a frame to station D

b. Both switches forward the frame

c. Both switches forward the frame

c. Both switches forward the frame



a. Actual system

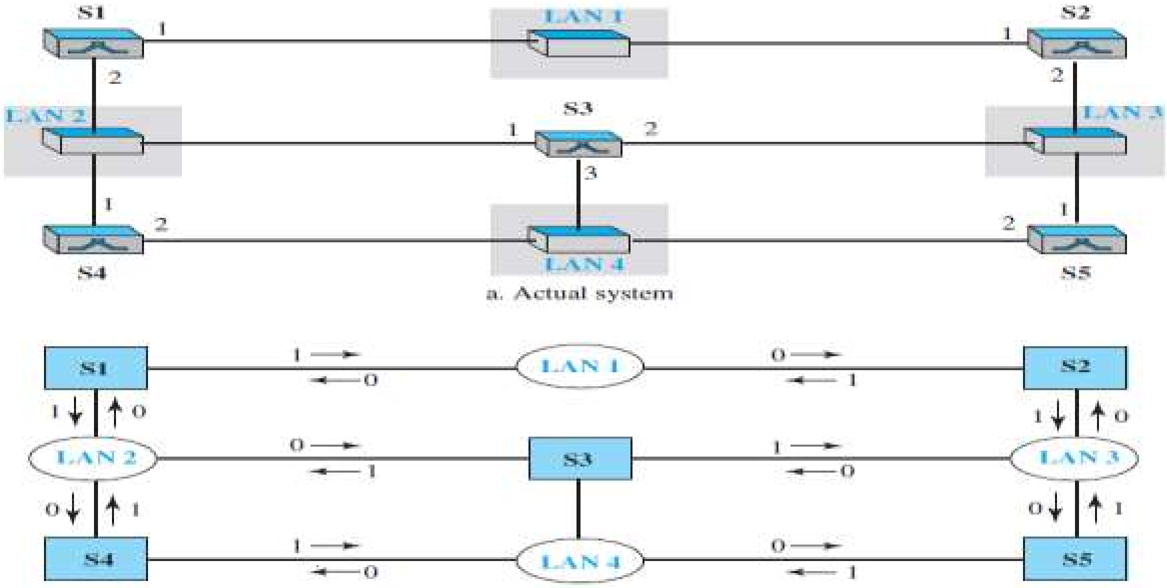
The process for finding the spanning tree involves three steps:

1. Every switch has a built-in ID (normally the serial number, which is unique). Each switch broadcasts this ID so that all switches know which one has the smallest ID. The switch with the smallest ID is selected as the root switch (root of the tree). Assume that switch S1 has the smallest ID. It is, therefore, selected as the root switch.

2. The algorithm tries to find the shortest path using Dijkstra algorithm (a path with the shortest cost) from the root switch to every other switch or LAN. The shortest path can be found by examining the total cost from the root switch to the destination. Figure shows the shortest paths.

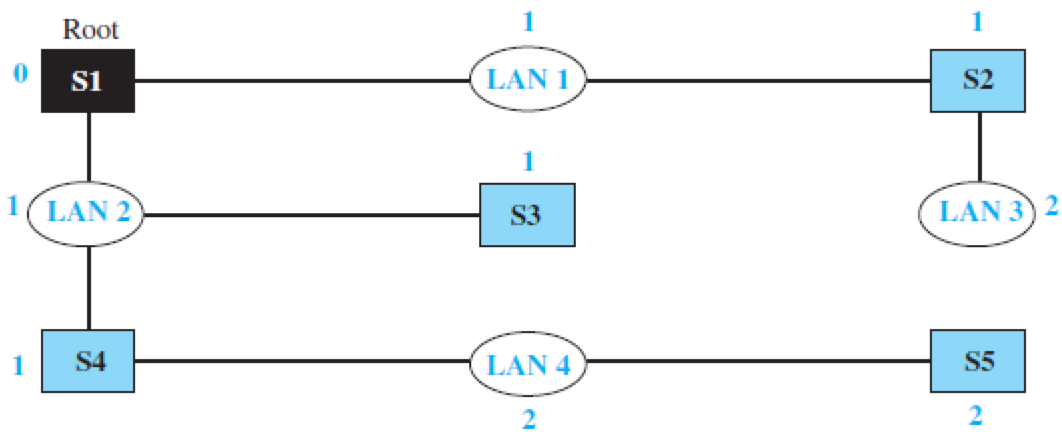
3. The combination of the shortest paths creates the shortest tree, which is also shown in Figure.

4. Based on the spanning tree, we mark the ports that are part of it, the forwarding ports, which forward a frame that the switch receives. We also mark those ports that are not part of the spanning tree, the blocking ports, which block the frames received by the switch. Figure shows the logical systems



a. Actual system

b. Graph representation with cost assigned to each arc



Q 8) An organization is granted a block of addresses with the beginning address 14.24.74.0/24. The organization needs to have 3 subblocks of addresses to use in its three subnets: one subblock of 10 addresses, one subblock of 60 addresses, and one subblock of 120 addresses. Design the subblocks and also find the first and last address of organization.

Solution:

There are 232 – 24 = 256 addresses in this block. The first address is 14.24.74.0/24; the last address is 14.24.74.255/24. To satisfy the third requirement, we assign addresses to subblocks, starting with the largest and ending with the smallest one.

a. The number of addresses in the largest subblock, which requires 120 addresses, is not a power of 2. We allocate 128 addresses. The subnet mask for this subnet can be found as n1 = 32 − log2128 = 25. The first address in this block is 14.24.74.0/25; the last address is 14.24.74.127/25.

b. The number of addresses in the second largest subblock, which requires 60 addresses, is not a power of 2 either. We allocate 64 addresses. The subnet mask for this subnet can be found as n2 = 32 − log264 = 26. The first address in this block is 14.24.74.128/26; the last address is 14.24.74.191/26.

c. The number of addresses in the smallest subblock, which requires 10 addresses, is not a power of 2 either. We allocate 16 addresses. The subnet mask for this subnet can be found as n3 = 32 − log216 = 28. The first address in this block is 14.24.74.192/28; the last address is 14.24.74.207/28.